

30 Years of Propulsion at MSFC

A Personal Perspective

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March 4, 2016

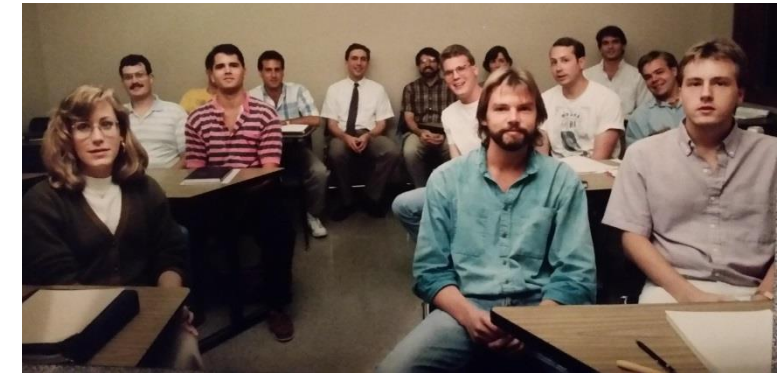
MSFC Propulsion Organization 1986

Purpose

- Provide propulsion products for the programs and projects we support
 - Engineering was the strongest organization at the center
 - Sometimes engineering managers chose what work we wanted to do
- Ensure our prime contractors were providing technically sound products
 - Our insight was often to perform independent analyses and compare answers
 - Contracts were structured such that engineers could call the contractor and ask them to do work for you
- Advance propulsion technologies and tools for fundamental understanding and infusion into our projects
 - Technology and tool development were gap-based and funding was focused on advancing our understanding
 - Frequently we did work in conjunction with or in partnership with our prime contractor counterparts
 - Sometimes technologies would be viewed as sandbox, we kept working after the project needs were met
- Educate our workforce
 - Training was technical and focused solely on improving our skills to do our technical jobs
 - Funding for advanced degrees and job related university classes was robust



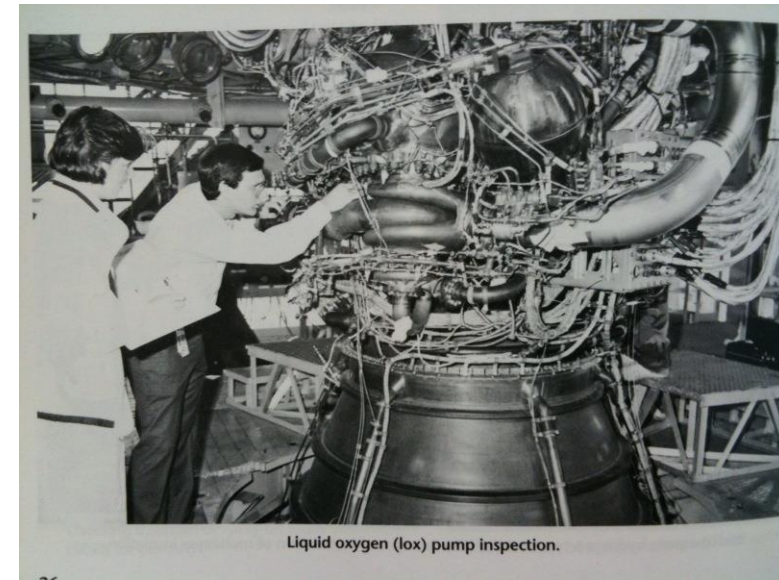
Turbine Test Equipment



UAH Propulsion Class
Dr Fredrick's first semester teaching.

Responsibility

- Product lines were not varied, Shuttle was propulsion's primary customer
 - Preponderance of our work was chemical, earth-to-orbit propulsion. We supported projects like Chandra, Hubble, and IUS; we had work in air-breathing, electric, and nuclear propulsion but the percentage of workforce that supported it was small.
 - We supported engineering boards; project boards were separate
 - With few products to support, managers were all very product focused and involved
- Propulsion Organization was responsible for liquid and solid chemical propulsion systems, components and the related analysis.
 - Work was predominately design, development, test and operations; research was applied
 - Detailed analysis disciplines (stress, thermal, design) were in another organization and discipline focused.
 - New skills were emerging for things like CFD – but no one ever considered it would become timely or accurate enough to be used to influence design. It was for trends or comparisons.
- Staffing was very deep
 - We had entire branches for skills like rotordynamics and tribology
 - Hiring was very significant in the 1980s, maintaining critical skills was less of an issue



Technology Test Bed



Emerging Analysis Techniques

Culture

- Our culture was very formal and hierarchical
 - People dressed up for work, white shirts, ties everyday.
 - There was no such thing as casual Fridays and if you happened to wear jeans while doing some test, you didn't dare ever present to your management still in those jeans.
 - Communication was through the chain of command
- The team was not diverse
 - Managers/leaders/supervisors were mostly white males
 - An attempt was being made to correct the geographic and gender differences
- Employee development was focused on the branch needs, product focused
 - Movement between organizations was not very frequent
 - Promotions were competitive and technical skills were the deciding factor in promotions.
 - Chief engineers provided mentoring and development of the technical team supporting them, sometimes more the was provided by the home organization



Engineering Management in the late 1980's



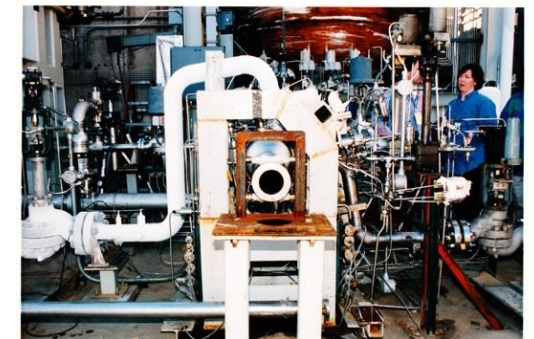
Wearing ties for ultrasonic inspections

Process / Systems

- Our systems had lots of rules, formality, paper driven.
- Computing tools were mainframe, email was not part of the organization.
 - Phone calls, memos and faxes were frequent methods of communication
 - Desktop computers were not available, data rooms were provided for accessing test data
- DDT&E cycle was very test-fail-fix based because we did not have the capability to analyze all of the complex attributes of our systems
 - Design processes were very labor intensive, a designer would draw something up on his drafting board, you would walk around drawings for signatures by drawing checkers, then signatures by the disciplines.
 - Analysis took a long time, often did not influence design, used frequently to resolve issues
 - Test rigs and test articles were plentiful and used to evaluate design changes for problems we were trying to solve
 - The test-fail-fix-cycles were costly but very beneficial in terms of employee learning



Viewgraph Machines, telecom systems, chalkboards, wooden pointers were common



Turbopump Testing

MSFC Propulsion Organization 2016

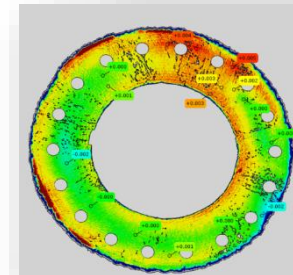
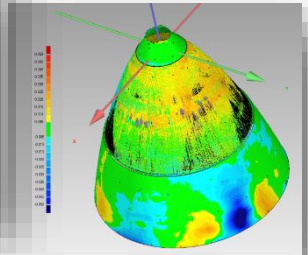
Purpose



- Main purpose of providing propulsion products for the projects has not changed
 - Many internal and external factors have refocused that purpose
 - Scope, focus and the numbers of programs and projects have changed significantly
 - Engineering and Projects are more partners in accomplishing goals
- Our role in support of primes is quite varied
 - Some areas still have traditional government insight models, albeit with smaller teams
 - Other areas we are relying on the contractor certification or providing support only in an as needed basis
 - Role with commercial partners is evolving
- Technology and tool development is often more focused
 - Technology and tool development is more project pull than technologist push
 - With an increase number of companies, technology is often more broadly focused
 - Funding is much more limited
- Educate our workforce
 - Training is more broadly focused
 - Soft skills are now a part of our training needs



CCP and SLS have much different operating models

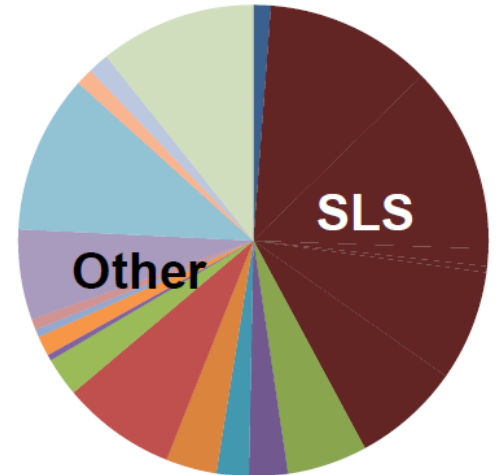


Structured Light is a broadly focused technology

Responsibility



- Responsibility has evolved significantly. Now the department supports more than 45 different projects. Many branches have more than two dozen customers
 - Employees often work multiple projects, teams getting smaller and staffed with less people than historically, each person expected to perform a broader array of skills
 - Projects with much smaller budgets than historically, affordability key driver
- We've grown capabilities in Main Propulsion Systems, thrust vector control, small solids, CFM, and Fluid Dynamics for example
- We have turned the responsibility for Low Earth Orbit (LEO) to commercial so we are helping them certify so we can focus on moving beyond LEO
- Ties to organizations such as advanced concepts much tighter, work ranges from conceptual, pre-formulation to operations, but much of the work is still in the middle
- Ties to other centers, government agencies, DoD, etc. becoming more critical



Current Propulsion
Workforce Deployment

Culture

- Our culture is not at all hierarchical, work environment is much more casual
- Movement between organizations is often and encouraged, others perspectives help integration and resolve conflict
- Promotions are competitive and often soft skills are a significant factor in promotions.
- Workforce is much more diverse, management is becoming more diverse
- Hiring limited and often focused on lower grades, much harder to replace lost critical skills
- Cost and schedule a now a focus for engineers as well as project managers
- Environmental impacts



Propulsion Systems Department Management

APPEL – Creativity and Innovation

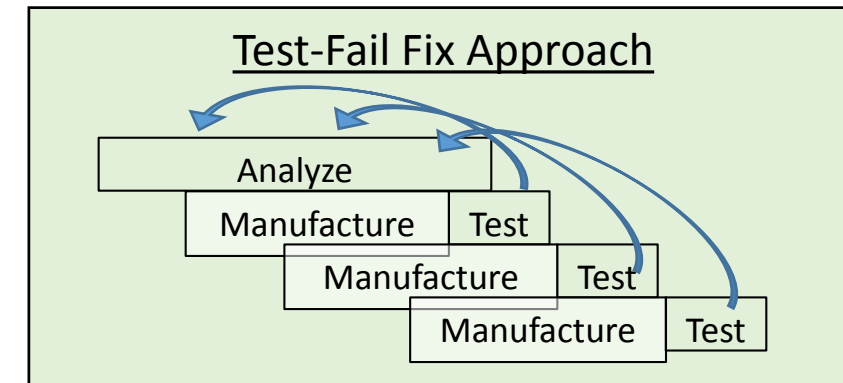
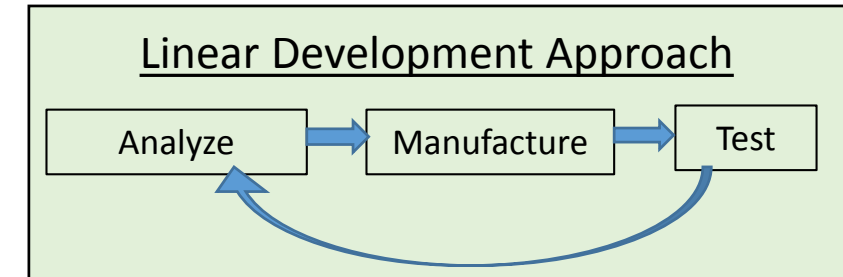
April 19-21, 2016

8 a.m. – 5:00 p.m.

Marshall Institute

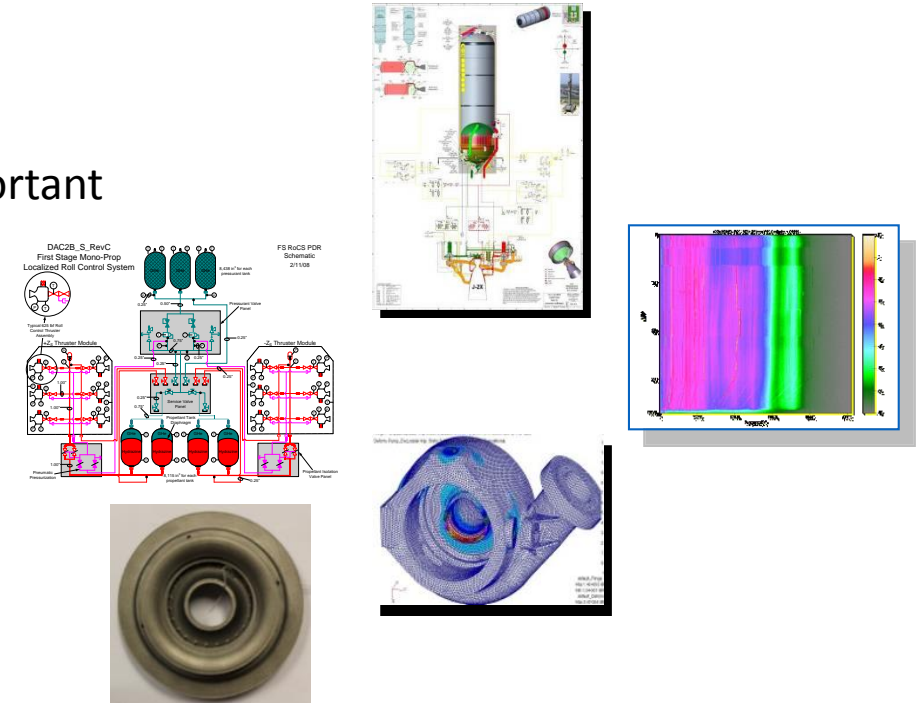
Process / Systems

- We have been working to remove structure and infuse flexibility depending on the type of project
- We have been looking to use technology to drive changes to the DDT&E process
- Systems are becoming less formal but more intertwined with other organizations such as collaborative design
 - Need advances in procurement, IT, HR, etc. to keep up
- IT has changed way we do analysis, influences design
- Processes are much more IT driven, worries about protecting data are significant.
- E-mail is critical and often the first choice over personal contact; not necessarily a good thing



Future

- Continual workforce downsizing, dispersed/reduced industrial base, IT advances, focus on affordability, & new technologies will drive us to become more revolutionary/innovative/ creative
- Workforce
 - Workforce more dispersed, teams smaller
 - Flexible workforce is a necessity
 - Organizational boundaries much more blurred; eliminating silos is important
 - Centers have to depend on each other
- IT driven
 - Analytical tool capabilities (loads)
 - Design to manufacturing
 - Work from anywhere
- Affordability focus
 - Commercial influence
 - Need to be more cost/schedule conscience – decisions may not be perfect but our job is to make them work
 - Need other orgs to have affordability focus (safety, procurement)
- Technologies
 - Additive, Structured light, who knows?



What we are doing to be prepared



- Encourage intentional detail assignments for employee focused development and broadening of perspectives
- Flexible workforce; multidiscipline engineers, continue to evolve technical skills
- **Soft skill focus**, encourage training in this area
- Commercial influence, how do we certify differently
- IT advances has led to new ways to do our jobs - Collaborative design process, loads modeling, timely analysis influencing design
- Rapid infusion of technologies
 - Learning to design with additive and structured light
 - How it impacts the DDTE cycle
 - How it impacts certification
- Critical to maintain some key critical skills due to reduction in industry
- Working much more closely with other center, partnerships a focus

